Exhibit 5-1

Ecological Soil Screening Level Guidance - Draft

Review of Background Concentrations for Metals

July 10, 2000

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1.0 INTRODUCTION

Many chemicals of concern commonly found at Superfund sites are also found in non-impacted areas and at concentrations that are not a result of site activities or releases; i.e., are found at background concentrations. Background concentrations may result from two sources: 1) naturally-occurring components of soil (e.g., aluminum, arsenic); and 2) anthropogenic releases that are not related to a hazardous waste site (e.g., lead from gasoline or PAHs from fossil fuel emissions). Accurately quantifying site-specific background concentrations of contaminants in soil may be important if the natural background concentrations are greater than the toxicity-derived ecological soil screening levels.

Ideally, this document would provide discrete contaminant concentrations that define the background concentrations for each contaminant applicable to soils across the United States. Unfortunately, this cannot be accomplished since soil characteristics are highly variable from state to state and from region to region (Connor and Shacklette 1975; Shacklette and Boerngen 1984). This document instead provides a summary of the data available on background concentrations in soil for contaminants for which ecological soil screening levels (Eco-SSLs) were developed. The purpose is to provide a range of background concentrations that are expected in soils across the United States that can be used to:

- Identify if the Eco-SSLs are near or below background soil concentrations; and
- Illustrate the importance of performing investigations to quantify background concentrations at some sites.

Little adequate and reliable data were found concerning background concentrations of organics in soils therefore the analyses is limited to metals. Metals are consistently found as components of soil in uncontaminated areas. In order to discern anthropogenic contributions from the natural concentrations of metals, it is important to define a range of background concentrations that are typically present in soil. Over 50 metals can be found in native soils; however, in support of the Eco-SSL guidance document, an abbreviated list of target metals was considered (Table 1-1). The subsequent sections summarize the methods used to obtain appropriate data and the compile that data into a database of background concentrations. The data is then subsequently used to describe typical background concentrations of metals found in soils across the United States.

Table 1.1 Metals Considered in Developing Ecological Soil Screening Levels (Eco-SSLs)	
Aluminum	Iron
Antimony	Lead
Arsenic	Manganese
Barium	Nickel
Beryllium	Selenium
Cadmium	Silver
Chromium	Vanadium
Cobalt	Zinc
Copper	

2.0 DATA REQUIREMENTS AND RETRIEVAL

When compiling information from a variety of data sets, it is important to realize that no single data set will contain all the information that is desired. Therefore, it is important to describe the scope of desirable data from which all potential data sources may be measured. This section summarizes both the list of data requirements identified and the data retrieval processes employed.

2.1 Data Requirements

Ideally, each data source contains the same information and meets all of the requirements for inclusion in the background database. However, this is not a realistic expectation given the fact that studies are performed across different soil types and sampling conditions for a variety of study objectives. Therefore, a list of data characteristics to be reviewed for each data source was compiled (Table 2.1) and segregated into two classifications: 1) mandatory; and 2) optional. Data characteristics that must be included in the data source are classified as mandatory, whereas data characteristics that are useful but not essential are classified as optional.

Table 2.1 Data Characteristics for the Review of Data Sources Reporting Contaminant Background Concentrations in Soil

Classification	Data Characteristic
Mandatory	Contains data on soils for an Eco-SSL contaminant of concern
	The data is representative of natural conditions (e.g., not impacted by site releases)
	Statistical (arithmetic or geometric) summaries clearly differentiated
Optional	Soil type or classification
	Wet-weight or dry-weight concentration
	Soil depth
	Geographic or regional location of soil
	Sample preparation and analysis methods
	Raw data reported

2.2 Data Retrieval

A literature review was performed to identify sources of information on background concentrations in soil for inorganic contaminants. The data retrieval consisted of a review of published data, a review of references from published literature, and an on-line (Internet) search to find additional state or federal publications. Data were retrieved from the following sources:

- CERCLIS-3 records associated with Superfund sites;
- United States Geological Survey (USGS) reports;
- Reports from State and other agencies; and
- Published literature.

Upon receipt, each source document (e.g., USGS report, literature article, etc.) was recorded onto a spreadsheet table for tracking purposes. Table 2.2 provides a summary of the source documents obtained. Each document was reviewed for data characteristics and these were recorded on the summary table. As was anticipated, the number of data characteristics reported varied significantly among the data sources. The studies which were contained the mandatory data characteristics are indicated on the Table as being included in the database.

2.3 Source Documents

The source documents obtained could be divided into three general categories: CERCLIS-3 database, USGS Nationwide studies, and state and other independent surveys. Each of the source documents for which data were included in the background soil concentration database are discussed in the following sections.

2.3.1 Background Concentrations from CERCLIS-3 Records

Source Data

The CERCLIS-3 database stores quantitative site data from each record of decision (ROD) that has been signed, generally since 1996. Although the CERCLIS-3 database is structured for easy retrieval of site-specific data, it was not possible to filter the background data set for surficial soils only. Therefore, all background concentrations in soil for the contaminants of concern were extracted. An EPA employee queried the CERCLIS-3 database yielding records reporting background concentrations in soil from 60 sites across the United States. The query output included the following information: EPA Region, state, site name, operable unit number, date the ROD was signed, contaminant name, contaminant background concentration, units of measure and the method used to determine the background concentration (e.g., 95% UCL, arithmetic mean, etc.). Often background data were provided for several operable units at a single site.

Table 2.2
Summary of Source Documents

Index	Author(s) and Date	Citation	Background Concentrations ?	Geographic		Soil	Soil	Wet or Dry Weight ?	Contaminants Cited	Data Samples Collected	Data Used in Database?
				Region	State	Depth	Type				
1	ADEQ (1991)	*Evaluation of Background Metals Concentrations in Arizona Soils* ; Arizona Department of Environmental Quality, Groundwater Hydrology Section, Phoenix, AZ. Prepared by The Earth Technology Corporation. June 1991.	Yes	WEST	AZ	Yes	NA	NA	Al, Sb, As, Ba, Cd, Cr, Co, Cu, Pb, Ni, Se, Ag, V, Zn	1961-1975	Yes
2	Breckenridge and Crockett (1995)	*Determination of Background Concentrations of Inorganics in Soils and Sediments at Hazardous Waste Sites* ; Technology Innovation Office, Office of Research and Development, Office of Solid Waste and Emergency Response; Washington D.C.; EPA/540/S-96/500. December 1995.	Yes	UNITED STATES--data presented on "soil type" level vs specific geographic location	NA	NA	15 different soil types	DRY WT.	As, Ba, Co, Cr, Cu, Mn, Ni, Pb, Se, Zn	NA	Yes
3	Conner and Shacklette (1975)	*Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States* ; USGS Professional Paper 574-F; U.S. Government Printing Office, Washington D.C.	Yes	WEST AND EAST	MO, GA, KY, MT, WY	NA-some studies give soil horizon with data	YES	NA	Al, Sb, As, Ba, Bo, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Ag, Zn	YES-in text summaries of studies	Yes
4	Delaware DNR and EC (1998)	*Delaware Default Background Remediation Standards* , Delaware Hazardous Substance Cleanup Act; February 1998	YES	NA	DE	NO	NO	NA	Al, Sb, As, Ba, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, V, Zn	NA	Yes
5	Efroymson, Will, and Sutter (1997)	*Toxicological Benchmarks for Contaminants of Potential Concenr for Effects on Soil and Litter Invertebrates and Heterotrophic Process: 1997 Revision* ; US Department of Energy, Office of Environmental Management. Prepared by Lockheed Martin Energy Systems, Inc. ES/ER/TM-126/R2. November 1997.	NO	NA	NA	NA	NA	NA	Al, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Ni, Se, Ag, V, Zn and some organics	NA	No
6	Illinois EPA (1997)	*Determining Area Background. Subpart D under Title 35 of Il Administrative Code*, Environmental Protection, Subtitle G: Waste Disposal, Chapter I: Pollution Control Board, Sub-Chapter F: Risk-Based Cleanup Objectives, Part 742 July 1997.	YES	NA	IL	NA	NA	NA	Al, Sb, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Ag, V, Zn	NA	Yes
7	Massachusetts Department of Environmental Protection (1995)	*Guidance for Disposal Site Risk Characteriziation* . MADEP Background Soil Concentrations. Boston, MA. July 1995.	NO	NA	NA	NA	NA	NA	Al, Sb, As, Ba, Cd, Cr, Co, Cu, Pb, Mn, Ni, Se, Ag, V, Zn	NA	No
8	McGovern (1988)	*Background Concentrations of 20 elements in soils with special regard for New York State* ; New York State Department of Environmental Conservation, Wildlife Resources Center 1988 (Unpublished).	Yes	East	NY	NA	YES-in text, however not for all values	DRY WT.	Al, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, V, Zn	YES-in text summaries	Yes
9	Michigan DNR (1991)	*Michigan Background Soil Survey (Revised, April 1991)* ; MERA Operational Memorandum #15, dated September 30, 1993.	Yes	NA	MI	NA	YES-topsoil/clay/silt/sand/peat*	NA	Ag, Al, As, Ba, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, Zn	YES-beginning 1987	Yes
10	Miesch (1967)	*Methods of Computation for Estimating Geochemical Abundances* ; US Geological Survey Professional Paper 574-B. Washington D.C. 1967	NO	NA	NA	NA	NA	NA	Fe, As	NA	No
11	Pierce, Dowdy, and Grigal (1982)	*Concentrations of 6 Trace metals in Some Major Minnesota Soil Series* ; Journal of Environmental Quality, Volume 11 pp. 416-422.	Yes	NA	MN	YES	YES	DRY WT.	Cd, Cr, Cu, Pb, Ni, Zn	NA	Yes
12	Shacklette and Boerngen (1984)	*Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States* ; USGS Professional Paper 1270, US Government Printing Office, Washington D.C. 1984	Yes	US	WI-and parts of neighboring states, MO (southeast), GA, KY, NV, NM, MD, AZ, CO, MT, UT, WY, ID, SD,	approx 20cm	NA	NA	Al, Sb, As, Ba, Cd, Cr, Co, Cu, F, Fe, Pb, Mn, Ni, Se, Ag, Zn,	1961-1970s	Yes
13	Washington Department of Ecology (1994)	*Natural Background Soil Metals Concentrations in Washington State* ; Toxics Cleanup Program, Department of Ecology. Publication No. 94-115. October 1994.	Yes	NA	WA	NA	YES	NA	Al, As, Cd, Cr, Fe, Mn, Ni, Pb, Zn	NA	Yes
14	Watkins, et. al. (1993)	*Final Report on the Background Soil Concentration Project at Oak Ridge Reservation Vols 1 and 2* . EE/ER/TM-84. Oak Ridge National Laboratory, Environmental Restoration Division. October 1993.	Yes	NA	TN-Oak Ridge Reservation	YES - by soil horizon	Soil types are described by the site locations, not for the individual samples taken	NA	Al, Sb, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Ag, V, Zn	1992	Yes

Table 2.2
Summary of Source Documents

Index	Author(s) and Date	Citation	Background Concentrations ?	Geographic		Soil	Soil	Wet or Dry Weight ?	Contaminants Cited	Data Samples Collected	Data Used in Database?
				Region	State	Depth	Type				
15	Bradford, et. al (1996)	*Background Concentrations of Trace and Major Elements in California Soils*; University of California, Division of Agriculture and Natural Resources. March 1996.	Yes	NA	CA	approx 50cm	Various	NA	Ag, Al, As, Ba, Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb, Se, V, Zn	1967	Yes
16	Ontario Ministry of Environment and Energy (1993)	*Ontario Typical Range of Chemical Parameters in Soil, Vegetation, Moss Bags and Snow, Version 1.0a*; Ministry of Environment and Energy. December 1993.	Yes	Canada	NA	NA	Class 1 Soil	NA	Al, Sb, As, Ba, Cd, Cr, Co, Cu, Fe, Pb, Mn, Ni, Se, Ag, V, Zn	NA	No
17	Ames and Hawkins (1997)	*Statistical Analysis and Areal Trends of Background Concentrations of Metals in Soils of Clark County, Washington*; USGS Water-Resources Investigations Report 96-4252, Tacoma, WA 1997.	Yes	NA	WA	YES - by soil horizon (A=2-6 in.; B=24-30 in)	Primarily alluvium	DRY WT.	Ag, Al, As, Ba, Cd, Co, Cr, Cu, Fe, Mn, Na, Pb, V, Zn	1991	Yes
18	Barringer, et. al (1998)	*Arsenic and Metals in Soils in the Vacinity of the Imperial Oil Company Superfund Site, Marlboro Township, Monmouth County, New Jersey*; USGS Water-Resources Investigations Report 98-4016. West Trenton, NJ 1998.	Yes	NA	NJ	YES - by soil horizon	Sand and clay	NA	Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Ni, K, Se, Ag, Na, Tl, V, Zn	1995	Yes
19	New Hampshire Division of Public Health Services (1991)	*Preliminary Survey of Metal Concentrations in New Hampshire Soils-Final Report*; New Hampshire Division of Public Health Services, Bureau of Health Risk Assessment. DPHS Document No. 91-004. May 1991.	Yes	NA	NH	YES - 0-6 inches	NA	NA	As, Cd, Cr, Ni, Pb	1989	Yes

NA= not available
ICP= Inductively Coupled Plasma
XRF= X-ray Flourescence
GFAA= Graphite Furnace Atomic Absorption
FLAA= Flame Atomic Absorption
CVAA= Cold Vapor Atomic Absorption

Data Use

The data for each Superfund site were reported using a variety of descriptive statistics including the arithmetic mean, geometric mean, standard deviation, minimum or maximum concentrations. These statistics, in addition to the number of records (n), are summarized in Table A-1. To avoid over representing the CERCLIS data, this data set was distilled so that only data point per contaminant per Superfund site was incorporated into the Background Soil database (n=60 sites).

2.3.2 Data from USGS Nationwide Soil Studies

Source Data

Two large data sets were obtained from the U.S. Geological Survey (USGS). Connor and Shacklette (1975) compiled the results of numerous studies carried out for samples of rock, soil, and plant material. Shacklette and Boerngen (1984) summarized background concentrations of metals present in surficial soil samples collected at a depth of 20 cm across the United States. The findings in these two publications were considered natural background concentrations because environmental samples were intentionally excluded in locations where metals concentrations were expected to be affected due to anthropogenic activities.

Data Use

Connor and Shacklette (1975) provided geometric mean, minimum and maximum values for both cultivated and uncultivated lands. Only background concentrations for uncultivated soils were included in the Background Soil Concentration Database. Approximately 350 records (at about 20 soil locations or depths) were incorporated. Arithmetic and geometric means, minimum and maximum values for approximately 60 records were incorporated into the database from Shacklette and Boerngen (1984).

2.3.3 Data from State or Other Independent Surveys

Additional background information was obtained from the following state or federal agencies:

- Washington State Department of Ecology
- Delaware Department of Environmental Quality
- Arizona Department of Environmental Quality
- Massachusetts Department of Environmental Protection
- Michigan Department of Natural Resources
- Illinois Environmental Protection Agency
- Minnesota state
- New York State Department of Environmental Conservation
- USGS Water Resources - New Jersey

- University of California-Division of Agriculture
- Oak Ridge National Laboratory

Washington State Department of Ecology

Source Data. The Washington State Department of Ecology published natural background concentrations for 12 metals in surficial soils throughout the state. A total of 490 soil samples were collected from 166 locations. The samples were collected from undisturbed and undeveloped areas from a depth of 0 to 3 feet (Ecology, 1994).

Data Use. Ecology (1994) provided geometric and arithmetic means, minimum, maximum and standard deviation values (1 record per metal). These data were incorporated into the Background Soil Concentration Database.

Delaware Department of Environmental Quality

Source Data. The Delaware Department of Environmental Quality published what they termed "default" background standards to be used for remediation purposes. These default values for 20 metals are the highest mean values of concentrations in soil samples collected at background locations at remediation sites across the state (Delaware DNR and EC 1998). The Delaware DNR and EC (1998) did not provide information on the type of mean value (arithmetic or geometric) presented. However, an agency representative was contacted and confirmed that the mean values represented are the arithmetic means.

Data Use. These data were incorporated into the Background Soil Concentration Database as arithmetic means.

Arizona Department of Environmental Quality

Source Data. The Arizona Department of Environmental Quality compiled approximately 62 data points on background soil concentrations obtained from the USGS survey and from independent statewide surveys soils. All samples were taken at depths ranging from 0.1 to 0.75 meters (ADEQ 1991). The individual raw data points were provided and an arithmetic mean was calculated (n =62). in addition to arithmetic mean, maximum, minimum and standard deviation values.

Data Use. The arithmetic means were entered into the Background Soil Concentration Database.

Massachusetts Department of Environmental Protection

Data Source. The Massachusetts Department of Environmental Protection has published background soil concentrations for 20 metals that reportedly represent non-urban (suburban and rural) areas. These concentrations may be used in lieu of site-specific background concentrations for risk assessments in Massachusetts (MADEP1995). MADEP (1995) provided information on both the arithmetic and geometric mean background value.

Data Use. The background concentrations were collected from "counties within metropolitan statistical areas". Therefore, samples used to represent background concentration values could have the following biases [excerpted from MADEP 1995, page 2-44]:

1) the samples were taken in the vicinity of disposal sites and may in fact have been affected by the contamination at the sites;

2) background samples are more likely to be taken (and reported to MADEP) in areas with relatively high background concentrations; samples are less likely to be taken if the concentrations at the site are so low that they are "obviously" background;

3) it is possible that some samples taken as background at sites were not included in reports submitted to MADEP;

4) high background samples at sites may have been mistaken for contaminated samples and not identified as "background".

Given the uncertainty in the accuracy of this data set to represent natural background concentrations, these data were not incorporated into the Background Soil Concentration Database.

Michigan Department of Natural Resources

Data Source. The Michigan Department of Natural Resources (MDNR) has collected 348 soil samples from various hazardous waste sites since 1987. Background concentrations are available for 16 metals from topsoil samples collected from geographically distinct areas within the state of Michigan (MDNR 1991).

Data Use. MDNR (1991) provided the arithmetic mean and standard deviation values for four soil types (topsoil, sand, silt and clay). Approximately 64 records were incorporated into the Background Soil Concentration Database.

Illinois Environmental Protection Agency

Data Source. The Illinois Environmental Protection Agency (ILEPA) has published background concentrations for 26 metals. These values are used for the development of remedial action objectives for public health risks as required under the State environmental regulations. The background concentrations as defined under these regulations, however, do not necessarily represent concentrations present under undisturbed conditions (ILEPA 1997). An agency representative was contacted to clarify the criteria used to define background conditions for the study. The representative stated that samples were collected from undisturbed and unimpacted sites.

Data Use. These data were incorporated into the Background Soil Concentration Database.

Study Specific to the State of Minnesota

Data Source: Soil background concentrations were retrieved from a paper published by Pierce et al. (1982) in which concentrations of six metals in some major Minnesota soils were reported. These soil types include the following: Loess, Superior Lobe Till, Rainy Lobe Till, Lacustrine, Wadena Lobe Till, Percy Till, Des Moines Lobe Till (prairie), Des Moines Lobe Till (forest). Weighted mean total metals, weighted mean total extractable metals and weighted standard deviations were reported.

Data Use. The weighted mean total metals data were incorporated into the Background Soil Concentration database.

New York State Department of Environmental Conservation

Data Source. The New York State Department of Environmental Conservation (NYDEC) produced an unpublished report prepared by McGovern (1988) that summarizes concentrations of 20 elements for New York and other East Coast states. These values were based on published literature from undisturbed and uncontaminated areas. The background concentrations were provided in a combination of geometric and arithmetic statistics. Generally, arithmetic means were provided for data sources citing the East, Maine and New Jersey. Geometric means were typically provided for data generated for New York.

Data Use. The arithmetic and geometric mean values were incorporated into the Background Soil Concentration database.

USGS Water Resources - New Jersey

Data Source. USGS Water Resources of New Jersey conducted a study on the background soil concentrations of 23 metals in the vicinity of the Imperial Oil Company NPL site. This study singled out uncultivated, cultivated and residential sites outside the boundaries of the NPL site. Various soil types including sand, silt and clay were included in the investigation and samples from 5 soil horizons (O, A, E, B and C) were collected (Barringer et al. 1998). Summary statistics were not provided within the document. However, the raw data were provided as an attachment

Data Use. . The individual raw data points for the undeveloped forest as well as the calculated arithmetic mean, standard deviation, minimum detected concentration and maximum detected concentration were entered into the Background Soil Concentration Database.

University of California-Division of Agriculture

Data Source. The University of California Division of Agriculture conducted a large-scale investigation in 1967 to determine the background concentrations of metals in surficial soils (at approximately a 50 cm depth). The study evaluated 22 different soil types (Bradford et al. 1996). Bradford et al. (1998) reported both arithmetic and geometric means, standard deviation, minimum and maximum for each of 46 metals.

Data Use. The arithmetic and geometric means, standard deviations, minimum and maximum detected concentrations for each of the 46 metals were incorporated into the Background Soil Concentration Database.

Oak Ridge National Laboratory (ORNL)

Data Source. The Oak Ridge National Laboratory (ORNL) conducted a study on the background soil concentrations of organics, metals and radionuclides in natural soil on the Oak Ridge Reservation. This study, known as the Background Soil Characterization Project, was part of the environmental restoration efforts undertaken by the ORNL (Watkins et al. 1993). The chemical concentrations in soil samples were considered natural background (Efroymson et al. 1997; Watkins et al. 1993). Statistical data in the Watkins et al. (1993) report included median and upper confidence concentration. However, individual raw data points were included as an attachment to the report.

Data Use. The individual raw data for metals were entered and the arithmetic mean, standard deviation, minimum and maximum values were calculated and incorporated into the database.

Breckenridge and Crockett (1995)

Data Source. Breckenridge and Crockett (1995) published a report providing remedial project managers (RPMs) and others investigating hazardous waste sites with a summary of technical issues that should be considered when determining if a site has elevated concentrations of inorganics relative to local background soil and/or sediment concentrations. Background is defined as the concentration of inorganics found in soils or sediments surrounding a waste site, but which are not influenced by site activities or releases. The background data they provide as concentration ranges (minimum to maximum) and mean values in selected surface soils for several United States soil types are taken from Kabata-Pendias and Pendias (1984). Background cadmium concentrations are not presented because its mobility is dependant upon soil pH and organic carbon content.

Data Use. The mean soil concentrations reported by Breckenridge and Crockett (1995) were incorporated into the Background Soil Concentration Database.

Ontario Ministry of Environment and Energy (OMOEE)

Data Source. The Ontario Ministry of Environment and Energy (OMOEE) published a report which developed new rigorous guidelines that would serve to establish background soil concentrations which, if exceeded, would prompt further site investigation to determine the significance of above-background concentrations. This study assembled a database of analytical results for environmental samples (soil, vegetation, moss, and snow) from non-point source-contaminated areas of Ontario, Canada (OMOEE, 1993).

Data Use. These data were not included in the Background Soil Concentration Database since soil sampling locations were in areas of Ontario, Canada, and not collected in the United States.

Ames and Hawkins (1997)

Data Source. Ames and Hawkins (1997) collected background soil data from Clark County, Washington, to determine if soil concentrations from sites of suspected contamination were elevated above background. Seventy-nine samples were randomly collected from 11 different soil types from areas that were relatively undisturbed by human activity. Concentrations for 17 metals, including 13 inorganic priority pollutants listed by the EPA, were analyzed for all soil samples. Summary statistics calculated included detection frequency, arithmetic mean, median, standard deviation, minimum, maximum, and the 90^{th} percentile.

Data Use. The arithmetic mean concentrations were incorporated into the Background Soil Concentration Database.

New Hampshire Division of Public Health Services (DPHS)

The New Hampshire Division of Public Health Services (DPHS) and the US Fish and Wildlife Service (USFWS) conducted a study to determine baseline concentrations of metals in soils throughout New Hampshire. Public schools from each state county were selected randomly and composite surface soil samples were collected in May and June of 1989. Raw data results are reported for arsenic, cadmium, chromium, mercury, nickel, and lead for each sample.

Data Use. Incorporation of these results into the Background Soil Concentration Database is pending.

3.0 DATABASE DEVELOPMENT

A Microsoft Access® database was structured such that records for each contaminant could be stored and retrieved by the soil type, geographic region, source document and statistics. Following evaluation and approval of the candidate data sets, data were compiled into the Microsoft Access® database. All of the mandatory requirements were met before a data source was introduced in the Background Soil Concentration Database

3.1 Data Evaluation

Section 2.3 and Table 2.1 provide a summary of the source data used in the database. Wherever soil depth was cited, only surface soils were retained in the Background Soil Concentration Database. As seen in Table 2.1, information concerning optional data characteristics such as soil type, wet-weight versus dry-weight, sample preparation and analysis methods were often not available.

Database Uncertainties

Because data incorporated into the Background Soil Concentration Database are mean values, these data (specifically non-detects) are already censored. In some cases (e.g., Bradford et al. 1998), non-detect values were reported at one-half the detection limit. This is the standard approach used in risk assessments. In other cases, the non-detect values may have been reported at the detection limit. Unfortunately, most data sources are silent as to how non-detects were handled in the calculation of statistics. The few raw data points reported as non-detects in the database were evaluated at the detection limit.

The topic of unreported detection limits was an issue during database development. Two publications reported non-detect values as "ND" (e.g., ADEQ 1991 and McGovern 1988) and did not report the associated detection limit. In these cases, the data point was removed from the database, since a numerical replacement could not be determined. As a result, the remaining data points may characterize a misleadingly high data set.

3.2 Transformation of Data

Most of the data sources used to compile data into the Background Soil Concentration Database provide arithmetic statistics only or both arithmetic and geometric statistics. However, there are some notable exceptions. Connor and Shacklette (1973) and McGovern (1988) [New York data only] report geometric means only. This combination of different reported statistical data make meaningful comparisons across data sets difficult. Therefore, the source data was normalized in the Background Soil Concentration Database. Data for which geometric mean and standard deviation were available were transformed to arithmetic mean values. A data set normalized to arithmetic mean (as opposed to geometric mean) was selected for two reasons. First, the source data primarily reports arithmetic means. Second, the arithmetic mean is historically used in risk assessment calculations such as determination of the 95% upper confidence limit, for example.

3.3 Distributional Characteristics

For each of the contaminants, the 5th, 25th, 50th (median), 75th and 95th percentiles of the means were determined and plotted as Box-and-Whisker plots. Box-and-whisker plots provide a visual summary of where the bulk of background data are concentrated and the shapes of each distribution. These plots display data under four quartiles with each quartile corresponding to four equal sized sets based on their rank.

Figure 3.1 presents box-and-whisker plots of background metal concentrations in soil as reported by geographic region or by unique data source (CERCLIS data) to discern relative differences in the distributional characteristics. As seen, contaminants such as aluminum, barium, iron and manganese display a wide concentration range. The wide range appears to be consistent across data sources and, therefore, represents the variability observed across the United States for these metals.

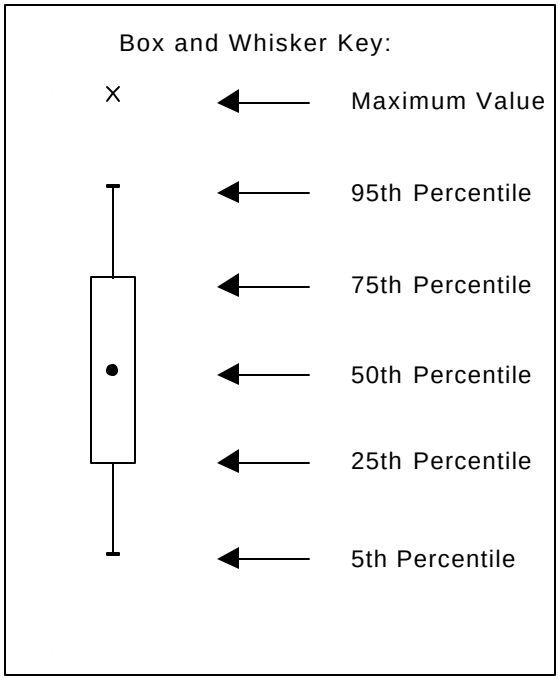
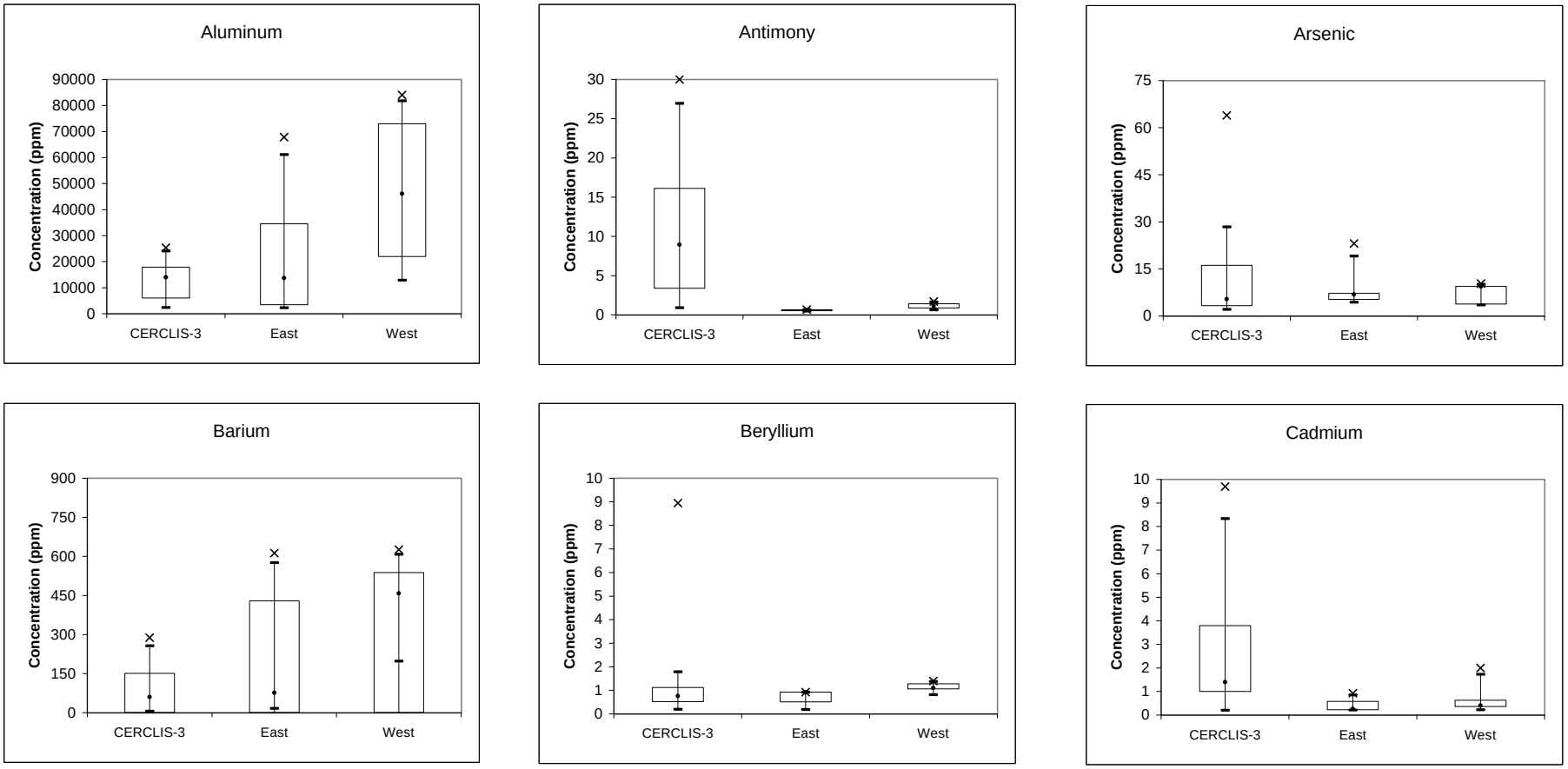


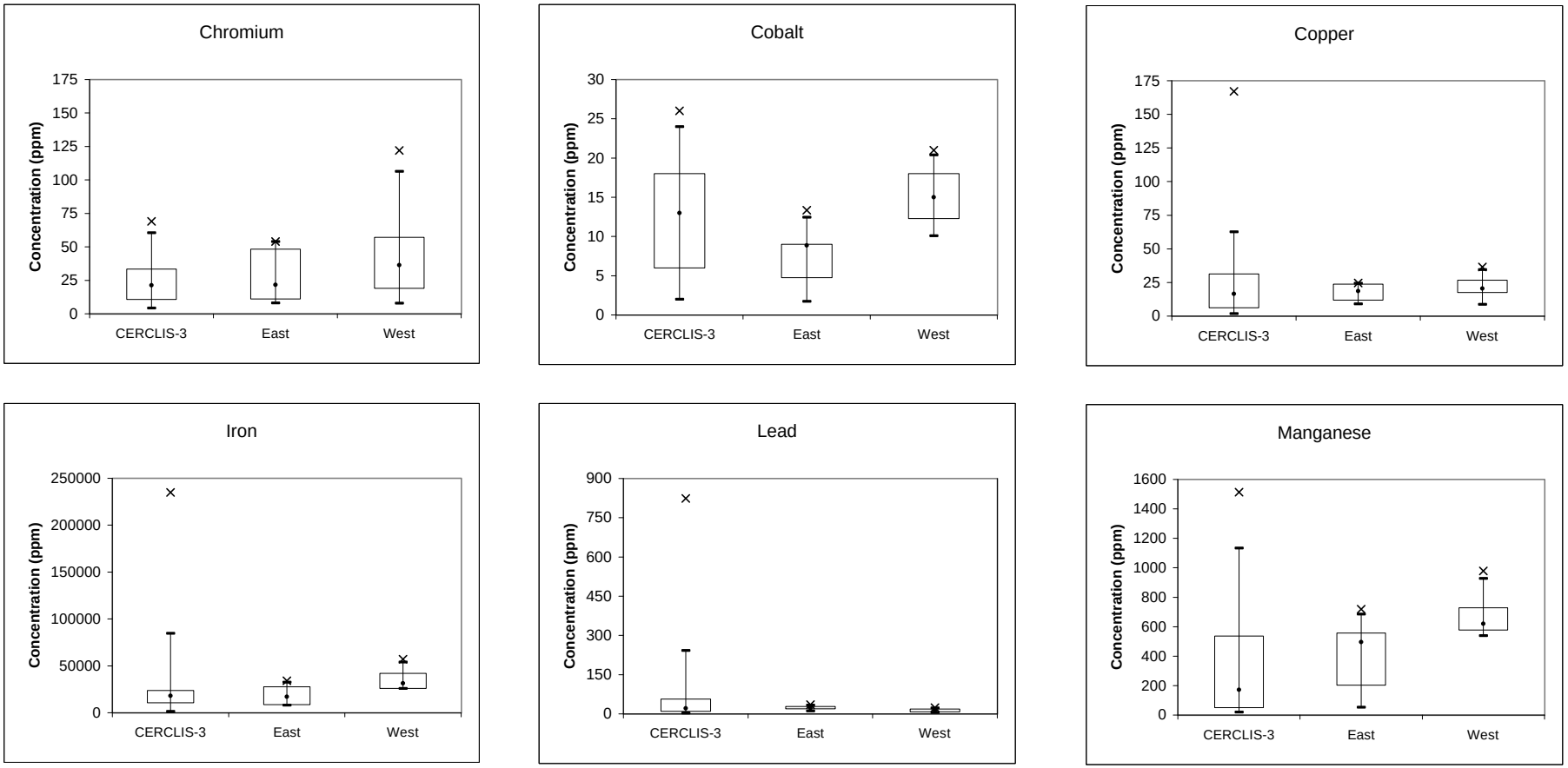
Figure 3.1 Box and Whisker Plots of Metal Concentrations as Reported by Region or Unique Data Source



Background data represented in these diagrams were compiled from the following sources: CERCLIS = CERCLIS Database Query; East = Individual Soil Studies Performed in States East of the Mississippi River; West = Individual Soil Studies Performed in States West of the Mississippi River

Note: All data presented in these figures have been evaluated using a database of arithmetic mean values.

Figure 3.1 Box and Whisker Plots of Metal Concentrations as Reported by Region or Unique Data Source



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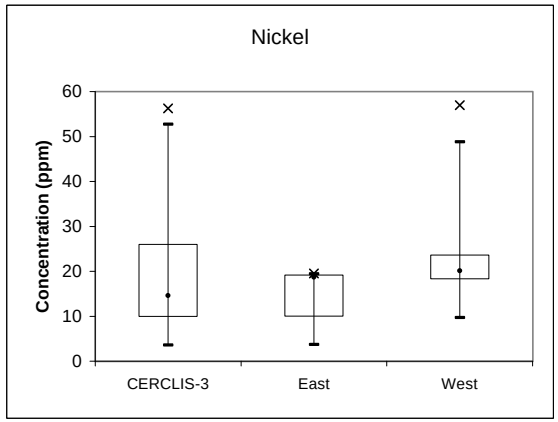

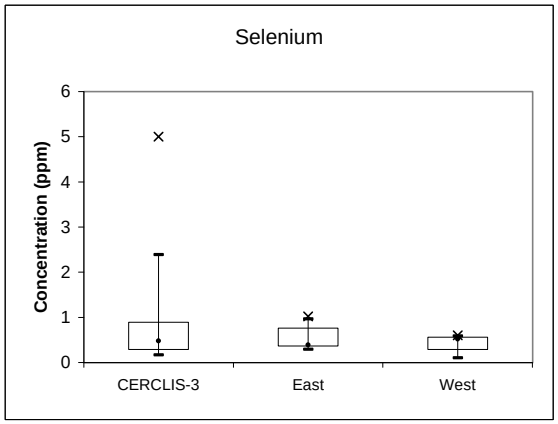

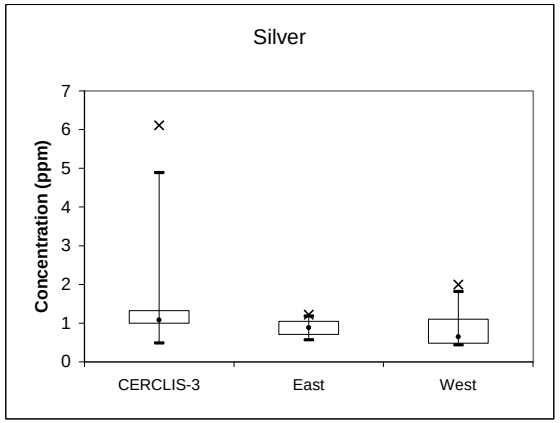

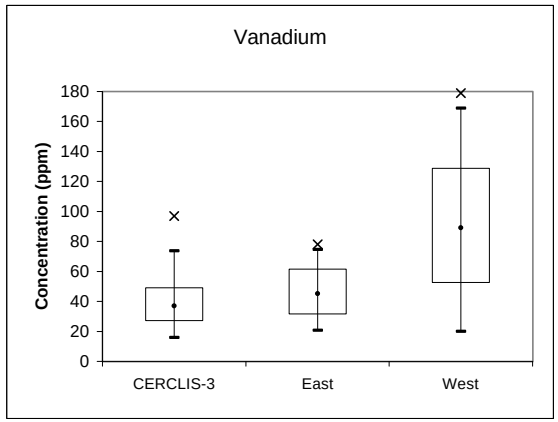

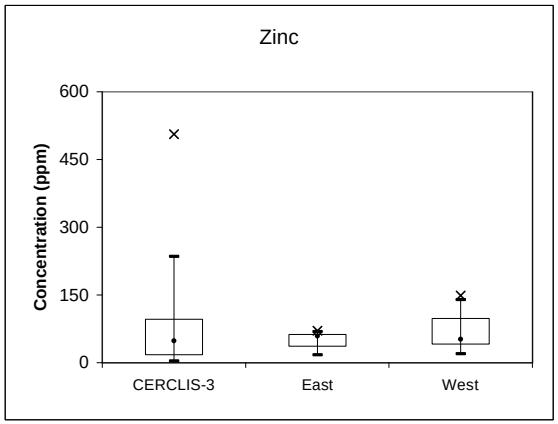

Background data represented in these diagrams were compiled from the following sources: CERCLIS = CERCLIS Database Query; East = Individual Soil Studies Performed in States East of the Mississippi River; West = Individual Soil Studies Performed in States West of the Mississippi River

Note: All data presented in these figures have been evaluated using a database of arithmetic mean values.

4.0 CONCLUSIONS

The box-and-whisker plots provide an at-glance statistical summary for both breadth and depth of background soil concentration data. These appear to indicate that:

- The median values generally reflect the central tendencies in the background data;
- Metals such as aluminum and iron were reported from all data sources and are consistently reported at very high concentrations (typically over 10,000 ppm); and
- Background concentrations of toxic heavy metals such as arsenic, beryllium, cadmium, copper, lead, and zinc fall are reported from most data sources within a relatively narrow concentration range.
- For a selected group of metals there is considerable regional variation (eastern US versus western US) which likely reflects natural variation in the geochemical composition of soils.

A comparison of this table to the Eco-SSL values reveals that typical background concentrations for several metals are below these screening values. This does not imply that soil in parts of the United States are naturally toxic to ecological receptors, although in some situations (i.e., low pH, low OC), this may be the case.

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ATTACHMENT A
DESCRIPTIVE STATISTICS CERCLIS DATABASE

Contaminant	Number of Records	Arithmetic Mean	Geometric Mean	SD	Max	Min	Regions Contributing to Database
Metals (in units of ppm)							
Al	22	13036	7148	7654	25400	0.63	1, 3, 4, 9, 10
Sb	7	9.78	0.332	10.97	30	0	3, 4, 5
As	36	10.7	2.25	12.81	63.9	0	1, 2, 3, 4, 5, 7, 8, 9, 10
Ba	24	90.0	20.3	90.67	288	0	1, 3, 4, 5, 7, 9
Be	24	1.14	0.360	1.74	8.95	0	1, 3, 4, 5, 8, 9, 10
Cd	22	2.13	0.021	2.91	9.7	0	1, 2, 3, 4, 5, 7, 8, 10
Cr	36	24.8	10.5	17.82	69	0	1, 3, 4, 5, 7, 8, 9, 10
Co	11	12.2	8.93	8.27	26	1.36	1, 3, 9
Cu	30	25.3	7.45	32.29	167	0	1, 2, 3, 4, 5, 7, 9, 10
Fe	18	30347	3211	52922	235000	0	1, 2, 3, 4, 5, 10
Pb	38	62.3	13.6	141	824	0	1, 3, 4, 5, 7, 8, 9, 10
Mn	26	348	62.5	410	1513	0	1, 3, 4, 5, 8, 9, 10
Ni	24	19.3	5.69	17.17	56.3	0	1, 2, 3, 4, 5, 7, 9, 10
Se	19	0.864	0.543	1.13	5	0.16	2, 3, 4, 7, 9, 10
Ag	12	1.44	0.051	1.72	6.11	0	1, 3, 4, 5, 10
V	22	38.6	12.6	23.19	96.9	0	1, 2, 3, 4, 5, 9, 10
Zn	28	77.0	18.1	104	506	0	1, 2, 3, 4, 5, 7, 9, 10